CSC 261/461 Database Systems

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Characteristics of Relations

Values in a tuple

- All values are considered atomic (indivisible).
- Each value in a tuple must be from the domain of the attribute for that column.
- A special `NULL` value is used to represent values that are unknown/inapplicable in certain tuples.

Constraints

Constraints

Determine which values are permissible and which are not in the database. They are of three main types:

1. Inherent or Implicit Constraints: These are based on the data model itself.
2. Schema-based or Explicit Constraints: They are expressed in the schema by using the facilities provided by the model.
3. Application based or semantic constraints: These are beyond the expressive power of the model and must be specified and enforced by the application programs.

Relational Integrity Constraints

- `Constraints` are conditions that must hold on `all` valid relation states.
- Three main types of constraints can be expressed in the relational model:
  - Key constraints
  - Entity integrity constraints
  - Referential integrity constraints

Key Constraints

- Superkey of R: Is a set of attributes SK of R such that:
  - No two tuples in any valid relation state r(R) will have the same value for SK
- Key of R: A "minimal" superkey
  - a key is a superkey K such that removal of any attribute from K results in a set of attributes that is not a superkey

Question: Is the key also a superkey? Is the SK a key? [PK]

Example

Keys and Superkeys

CAR

License_number	Engine_serial_number	Make	Model	Year
Texas ABC-739	A69352	Ford	Mustang	02
Florida TVP-347	B43696	Oldsmobile	Cutlass	05
New York MPO-22	X83554	Oldsmobile	Delta	01
California 432-TFY	C43742	Mercedes	190-D	99
California RSK-629	Y82935	Toyota	Camry	04
Texas RSK-629	U028365	Jaguar	XJS	04

Entity Integrity

Entity Integrity

- The primary key attributes PK cannot have `NULL` values.
  - This is because primary key values are used to identify the individual tuples.
  - If PK has several attributes, `NULL` is not allowed in any of the attributes
- Other attributes of R may be constrained to disallow `NULL` values.

Referential Integrity

Referential Integrity

- A constraint involving two relations
- Used to specify a relationship among tuples in two relations:
  - The `referencing` relation and the `referenced` relation.
- attributes in FK have the same domain(s) as the attributes PK of R2.
- Attributes FK in R1 reference the PK attributes PK in R2.
  - A tuple t1 in R1 is said to reference a tuple t2 in R2 if $t1[FK] = t2[PK]$.

Referential Integrity

Example

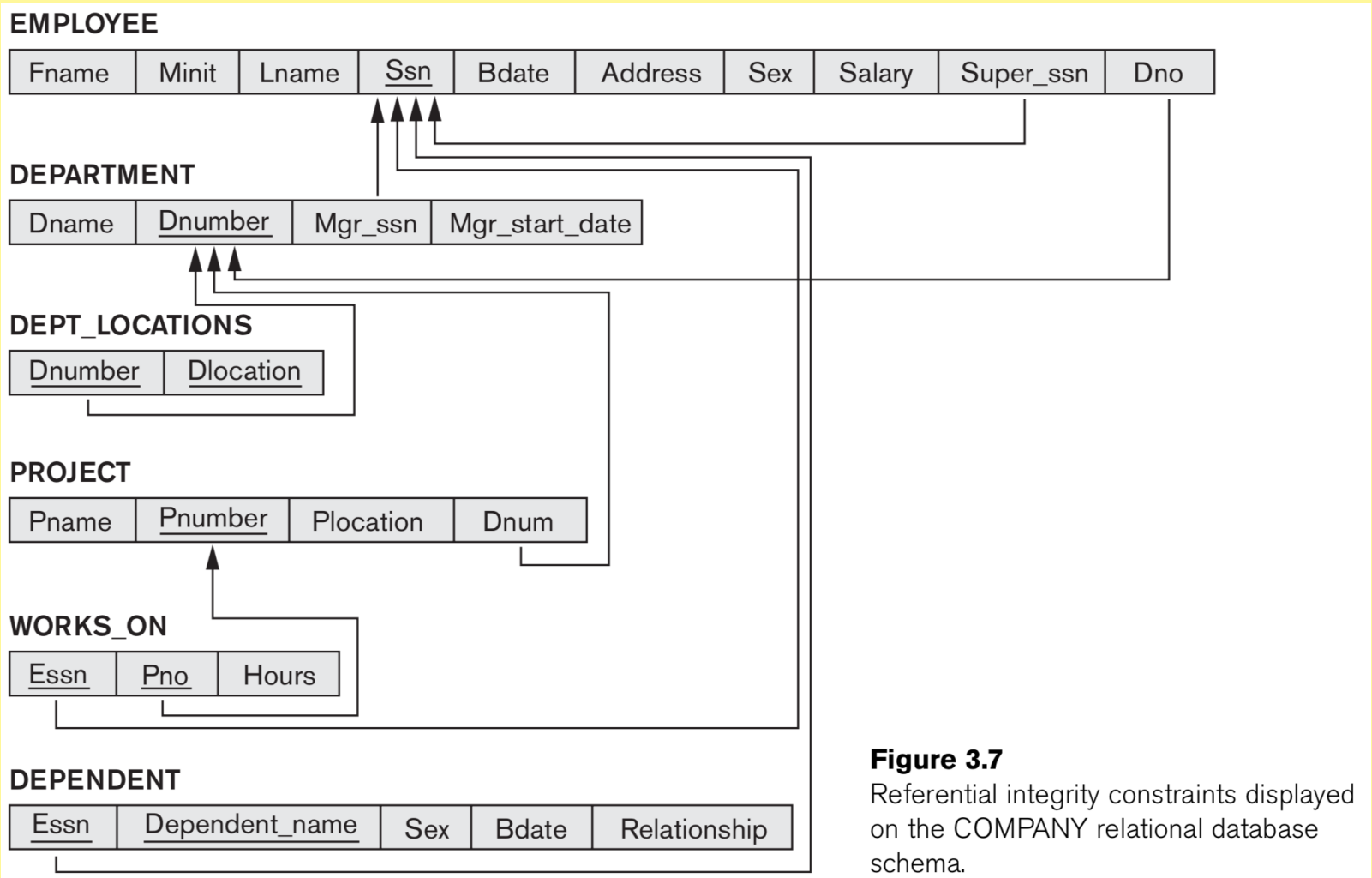


Figure 3.7
Referential integrity constraints displayed on the COMPANY relational database schema.

Structured Query Language

Declaring Keys

- There are two declarations that may be used to indicate keys
  1. `PRIMARY KEY`
  2. `UNIQUE`
- the effect of declaring a set of attributes S to be a key is:
  - two tuples in R cannot agree on all of the attributes in set S, unless one of them is `NULL`.
  - any attempt to insert or update a tuple that violates this rule is rejected.
  - if `PRIMARY KEY` is used, then attributes in S do not allow `NULL` as value.

Structured Query Language

Referential Integrity

- Referential integrity is specified via `FOREIGN KEY`.
- referential integrity can be violated
  - when tuples are inserted or deleted, or
  - when a foreign key or primary key attribute value is modified.
- The default action that SQL takes for an integrity violation is to reject the operation
  - this is known as the `RESTRICT` option.

Structured Query Language

Atribute and Tuple Constraints

In a `CREATE TABLE` statement, we can declare two kinds of constraints:

1. A constraint on a single attribute.

```
gender CHAR(1) CHECK (gender IN ('F', 'M'))
```

2. A constraint on a tuple as a whole.

```
CHECK (gender = 'F' OR name LIKE 'Mr.%')
```

Update Operations on Relations

Operations

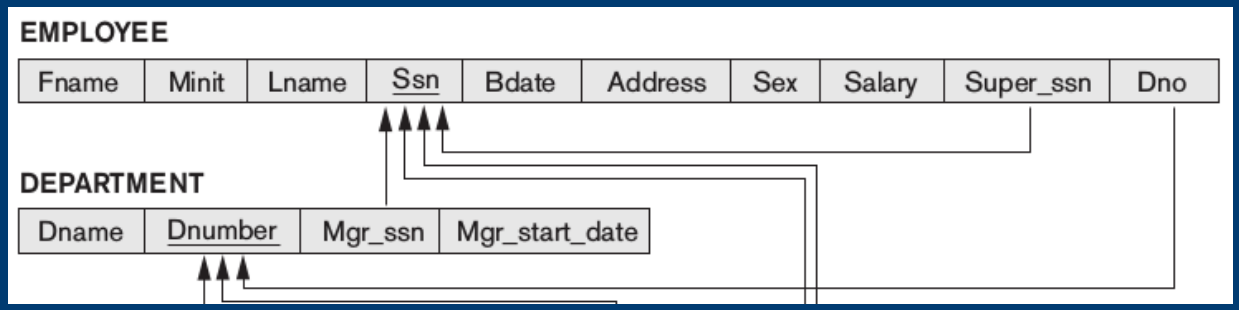
- INSERT a tuple.
- DELETE a tuple.
- MODIFY a tuple.
- Integrity constraints *should not* be violated by the update operations.

Possible Violations

INSERT

- Domain constraint:
  - if one of the attribute values provided for the new tuple is not of the specified attribute domain
- Key constraint:
  - if the value of a key attribute in the new tuple already exists in another tuple in the relation
- Referential integrity:
  - if a foreign key value in the new tuple references a primary key value that does not exist in the referenced relation
- Entity integrity:
  - if the primary key value is NULL in the new tuple

Examples



EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

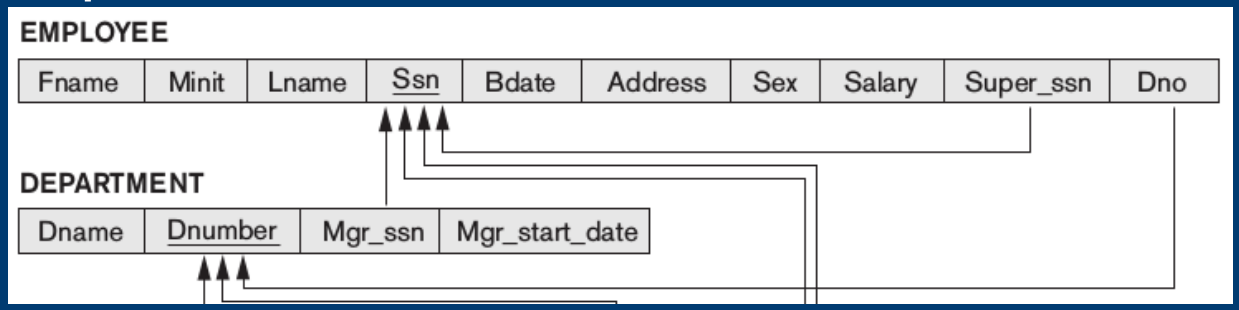
DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland

Insert <'Alicia', 'J', 'Zelaya', '999887777', '1960-04-05', '6357 Windy Lane, Katy, TX', F, 28000, '987654321', 4> into EMPLOYEE.

Insert <'Cecilia', 'F', 'Kolonsky', NULL, '1960-04-05', '6357 Windy Lane, Katy, TX', F, 28000, NULL, 4> into EMPLOYEE.

Examples



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Insert <'Cecilia', 'F', 'Kolonsky', '677678989', '1960-04-05', '6357 Windswept, Katy, TX', F, 28000, '987654321', 7> into EMPLOYEE.

Insert <'Cecilia', 'F', 'Kolonsky', '677678989', '1960-04-05', '6357 Windy Lane, Katy, TX', F, 28000, NULL, 4> into EMPLOYEE.

Possible Violations

DELETE

- DELETE may violate only referential integrity:
  - If the primary key value of the tuple being deleted is referenced from other tuples in the database
  - RESTRICT option: reject the deletion
  - CASCADE option: attempt to cascade the deletion by deleting tuples that reference the deleted tuple
  - SET NULL option: set the foreign keys of the referencing tuples to NULL

Possible Violations

UPDATE

- UPDATE may violate domain or NOT NULL constraint
- Any of the other constraints may also be violated:
  - Updating the primary key (PK):
    - Similar to a DELETE followed by an INSERT
    - Need to specify similar options to DELETE
  - Updating a foreign key (FK):
    - May violate referential integrity
  - Updating an ordinary attribute (neither PK nor FK):
    - Can only violate domain constraints

Questions?

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